



## DOE's FUEL CELL RESEARCH TARGETS NATIONAL GOALS FOR ENERGY AND THE ENVIRONMENT

### CONTACT POINTS

**Mark C. Williams**  
Product Manager  
Fuel Cells  
304-285-4747  
mark.williams@netl.doe.gov

**Wayne A. Surdoval**  
SECA Coordinator  
412-386-6002  
wayne.surdoval@netl.doe.gov

**Julianne Klara**  
Senior Analyst  
412-386-6089  
julianne.klara@netl.doe.gov

**Heather Quedenfeld**  
Senior Analyst  
304-285-5430  
heather.quedenfeld@netl.doe.gov

### NETL WEBSITE

[www.netl.doe.gov/](http://www.netl.doe.gov/)

### STRATEGIC CENTER FOR NATURAL GAS WEBSITE

[www.netl.doe.gov/scng/](http://www.netl.doe.gov/scng/)

U.S. electricity generation capacity will need to increase by 350 GW in the next 20 years to meet a 55% increase in demand.<sup>1</sup> At the same time, generators will be expected to lower their NO<sub>x</sub>, SO<sub>x</sub>, and CO<sub>2</sub> emissions. Cleaner power generation technologies such as fuel cells will enable us to meet these challenges. In addition to generating cleaner electricity, fuel efficient fuel cells will increase our nation's energy security, as they run on domestic resources, such as natural gas.

The cornerstone of NETL's fuel cell research is the Solid-State Energy Conversion Alliance (SECA). SECA will develop a solid-oxide fuel cell that is versatile and cost-competitive. SECA research will overcome technical and cost barriers, making fuel cells available for many applications, from powering our homes and businesses to providing auxiliary power in cars and trucks. Project descriptions available at [www.netl.doe.gov/scng](http://www.netl.doe.gov/scng)

### Fuel Cell Research at NETL Targets Three Key Initiatives for Energy and the Environment

#### 1. Clear Skies Initiative:

Clear Skies is a comprehensive policy to reduce emissions of SO<sub>x</sub>, NO<sub>x</sub>, and mercury from the power generation sector, using a cap and trade program.

#### 2. Climate Change Initiative:

The goal of this voluntary program is to cut U.S. greenhouse gas (GHG) emissions and reduce GHG intensity 18% by 2012. The market-based program could develop tools to measure and trade emissions credits.

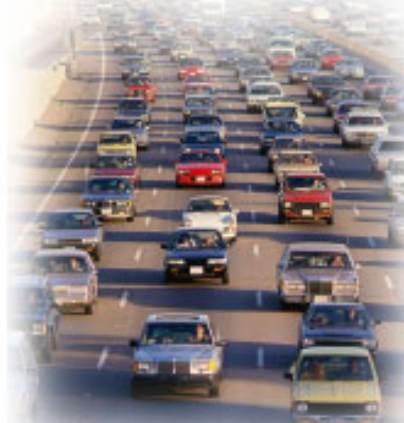
#### 3. Energy Security: This program seeks to diversify energy resources and develop new technologies for distributed power. The program also promotes conservation, use of domestic energy resources, and modernization of energy delivery systems.





## Direct Environmental Benefits

By 2025, replacing central power stations with fuel cells as distributed generation provides annual NO<sub>x</sub> and CO<sub>2</sub> reductions equivalent to removing over 22.7 million cars from the road and retiring nearly 50 aging 500 MW coal-fired plants.<sup>3</sup>



Successful fuel cell research creates a stepping stone to the hydrogen economy, another focus of U.S. energy R&D, known as the *Hydrogen Fuel Initiative*. Fuel cells that utilize natural gas and other fossil fuels today will lead the way to hydrogen-based energy systems of tomorrow. Hydrogen-powered fuel cells will be pollution free and suitable for use in cars, trucks, homes and businesses, thus reducing air pollution and dependence on foreign oil.

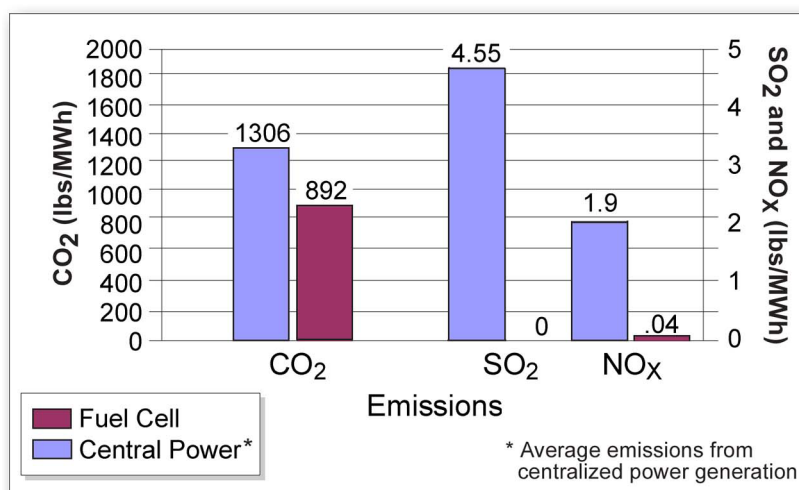
## Fuel Cells: Clear Skies and Climate Change

Fuel cells are an attractive power generation option because they use an electrochemical process instead of combustion. This virtually eliminates the formation of pollutants, including nitrogen oxides, sulfur oxides, hydrocarbons, and particulate matter. Fuel cells also release substantially less carbon dioxide than gas or coal-fired power plants, due to their efficient operation. Widespread use of fuel cell technology could make a significant improvement in air quality and reduce greenhouse gas emission in the U.S.

The fuel cells being developed under the SECA program will reduce emissions of SO<sub>2</sub>, NO<sub>x</sub>, mercury and CO<sub>2</sub> compared to the use of conventional technologies for power generation. When compared to average grid power, SECA fuel cells dramatically reduce air pollution.

- At least 98% reduction of NO<sub>x</sub> and SO<sub>2</sub> emissions per MWh
- Greater than 21% reduction in CO<sub>2</sub> emissions per MWh without the need for sequestration.
- Negligible mercury emissions

## Every MWh of Fuel Cell Use Reduces Air Emissions



By 2025, replacing as much as 72 GW<sup>2</sup> of central power with fuel cells will

- Reduce NO<sub>x</sub> emissions by nearly 6 million tons,
- Reduce CO<sub>2</sub> emissions by greater than 900 million tons, and
- Significantly reduce emissions of SO<sub>2</sub>, mercury and other pollutants when compared to average grid emissions.

## Fuel Cells: Energy Security

Fuel cells can provide a cost effective alternative to central power generation. By utilizing distributed generation, reliance on large central facilities is reduced, decreasing vulnerability to accidental or intentional attack. Recent power outages like the August 2003 blackout in the Northeast would have been alleviated with true distributed generation. Fuel cells provide an easy means to upgrade overloaded substations, easing congestion and subsequently reducing the need for new transmission lines. The short construction lead-time for fuel cells provides rapid response to unanticipated growth in demand, particularly for highly efficient generation of combined heat and power.

Fuel cells operating on natural gas, coal-derived gas or other fossil fuels are the first-step on a pathway to a hydrogen fueled economy. Natural gas reforming and coal gasification will supply hydrogen for fuel cells, providing efficient electricity, space heating and transportation energy for our Nation without the need to rely on foreign fuel sources.

## Why Do We Need Fuel Cell Research?

Fuel cells save money for consumers, reduce harmful pollution, and lead the way toward a hydrogen-based energy system. Fuel cell commercialization has suffered from a lack of longer-term research and development. Industry prefers lower-risk research that enhances short-term competitiveness and often resists participating in collaborative research that may also benefit their competitors. The gap between low-risk short-term research and high-risk long-term research is being bridged by federal investment in R&D programs such as SECA. By coordinating research to address the most difficult issues first, the government also plays a key role in leveraging knowledge and innovation, accelerating commercialization of fuel cell technology.

By 2025, fuel cell capacity is projected to reach 72 GW, which includes natural gas fueled fuel cells and fuel cell-turbine hybrid systems deployed in advanced coal-based power plants. A recent analysis projects that this level of fuel cell capacity saves consumers \$58 billion on their electricity expenditures<sup>2</sup>.

*Recent power outages like the August 2003 blackout in the Northeast would have been alleviated with true distributed generation.*

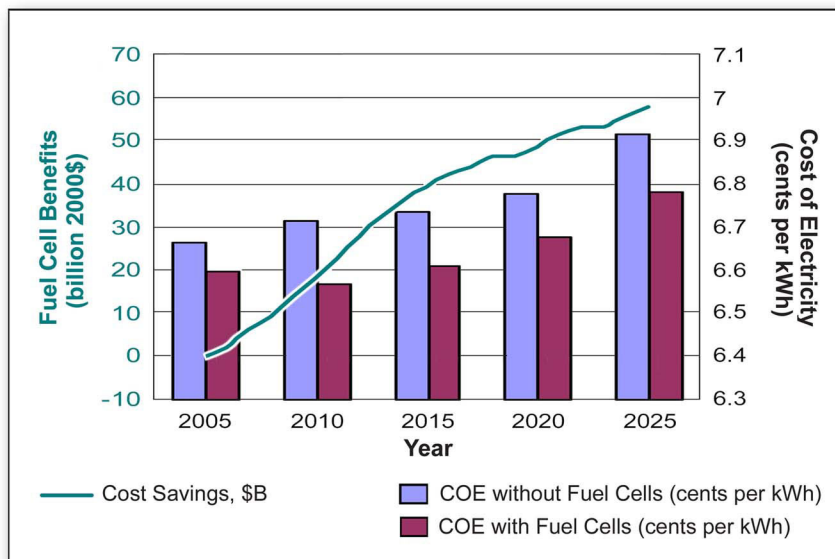


# DOE's FUEL CELL RESEARCH TARGETS NATIONAL GOALS FOR ENERGY AND THE ENVIRONMENT

## Cost Savings to Consumers from Fuel Cell Technologies

### Auxiliary Power for Transportation Applications

DOE's SECA program is developing solid state fuel cells that will have a spin-off application in the transportation sector. Using fuel cells rather than idling engines for auxiliary power will result in savings of more than 400 million gallons of diesel fuel per year and 4.6 million tons of CO<sub>2</sub> annually.<sup>4</sup>



### FutureGen

The *FutureGen Initiative* integrates sequestration and the hydrogen economy. It aims to design, build, and operate nearly emission-free, coal-fired electric and hydrogen co-production plants. The Department of Energy envisions that this project will serve as the test bed for new technologies for well into the coming decade and beyond.

Virtually every aspect of the prototype plant will be based on cutting-edge technology. A FutureGen plant will turn coal into a hydrogen-rich gas, rather than burn the coal directly. The hydrogen could then be combusted in a turbine or used in a SECA fuel cell to produce clean electricity. In the future the plant could become a model hydrogen production facility for hydrogen-powered cars and trucks.

- 1 U.S. Department of Energy, Energy Information Administration, 2003. Annual Energy Outlook 2003. DOE/EIA-0383(2003).
- 2 Internal FE Benefit Analysis. Benefits are based on an analysis using EIA's National Energy Modeling System (NEMS). NEMS inputs were updated using DOE/FE's program targets for the SECA program and advanced coal power systems using fuel cells. Cases were run both with and without the inclusion of these advanced technologies. Results cited are for the high gas price scenario.
- 3 Science Applications International Corporation (SAIC), 2002. Value of Natural Gas R&D at NETL and <http://www.epa.gov/otaq/consumer/f00013.htm>.
- 4 Parsons Infrastructure and Technology Group. Dec. 2000. "Preliminary Assessment of Planar Solid Oxide Fuel Cells for Transportation Power Applications." Prepared for Argonne National Laboratory.